



UNIVERSITY OF COPENHAGEN



BEYOND NUTRIENTS: HEALTH EFFECTS OF THE DAIRY MATRIX

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DIETARY GUIDELINES 2015-2020



Key Recommendations



Consume a healthy eating pattern that accounts for all foods and beverages within an appropriate calorie level.

A healthy eating pattern includes:^[2]

- A variety of vegetables from all of the subgroups—dark green, red and orange, legumes (beans and peas), starchy, and other
- Fruits, especially whole fruits
- Grains, at least half of which are whole grains
- Fat-free or low-fat dairy, including milk, yogurt, cheese, and/or fortified soy beverages
- A variety of protein foods, including seafood, lean meats and poultry, eggs, legumes (beans and peas), and nuts, seeds, and soy products
- Oils



A healthy eating pattern limits:

- Saturated fats and *trans* fats, added sugars, and sodium

Key Recommendations that are quantitative are provided for several components of the diet that should be limited. These components are of particular public health concern in the United States, and the specified limits can help individuals achieve healthy eating patterns within calorie limits:

- Consume less than 10 percent of calories per day from added sugars^[3]

EFSA: As low as possible

- Consume less than 2,300 milligrams (mg) per day of sodium^[5]
- If alcohol is consumed, it should be consumed in moderation—up to one drink per day for women and up to two drinks per day for men—and only by adults of legal drinking age.^[6]

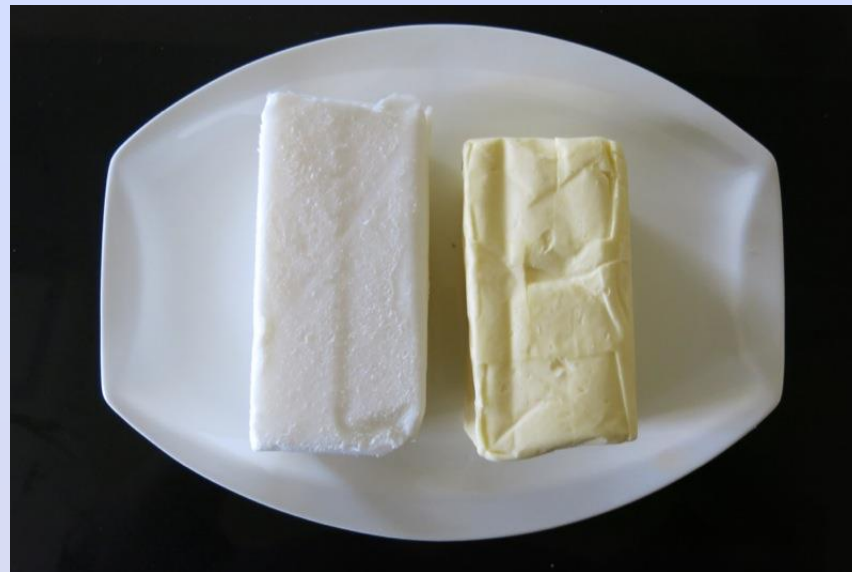
“People don’t want to hear the truth because they don’t want their illusions destroyed.”

Friedrich Nietzsche

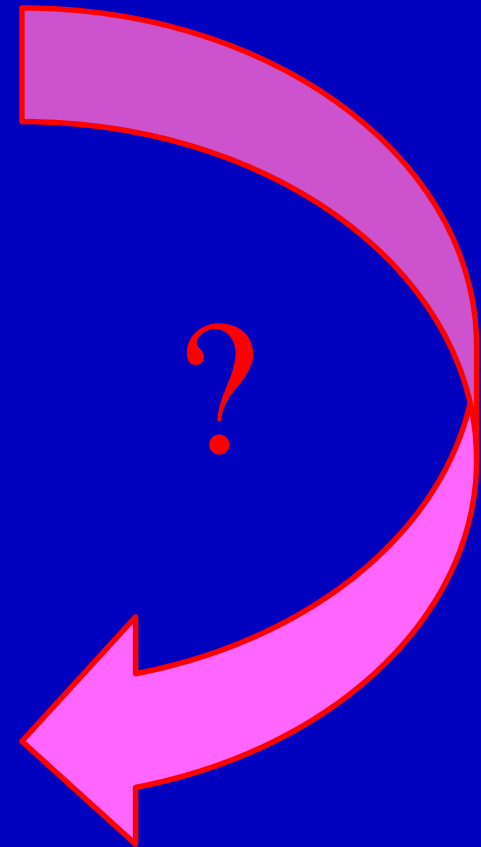
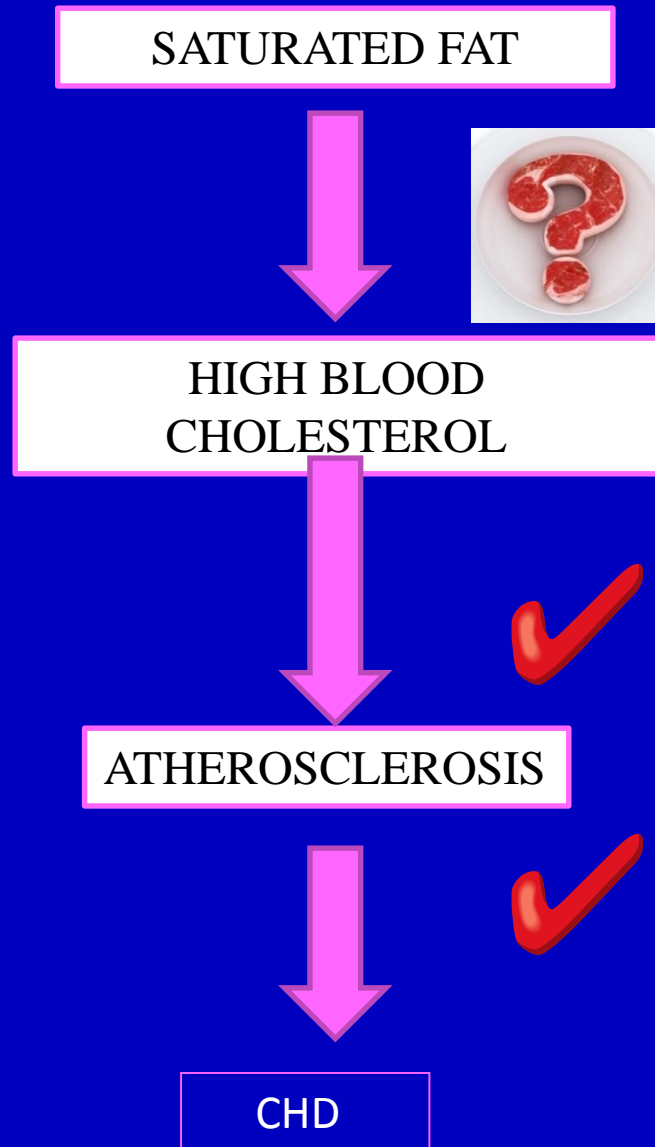


Saturated fat intake and CVD risk

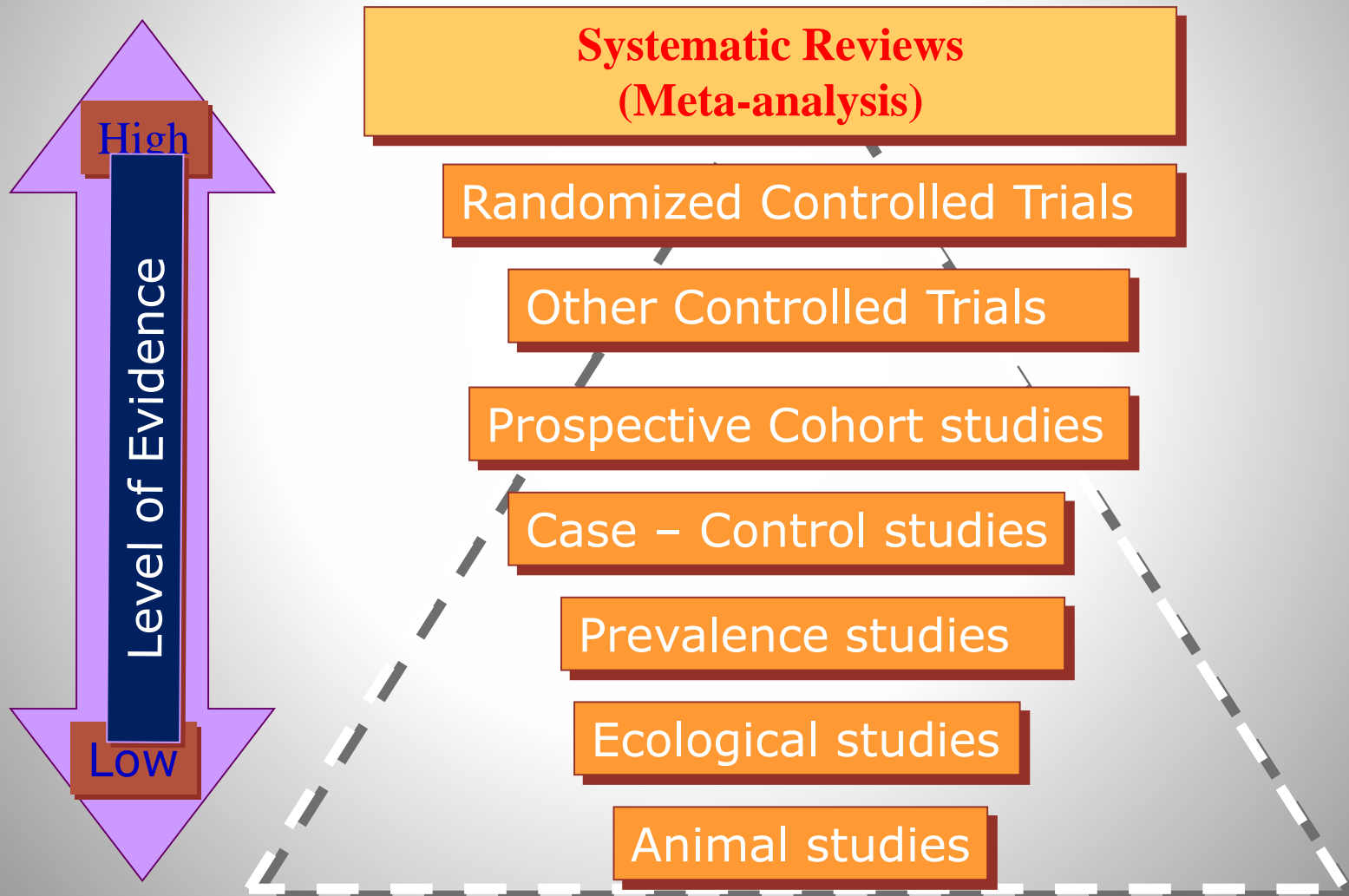
-the most recent evidence



The lipid hypothesis and CHD

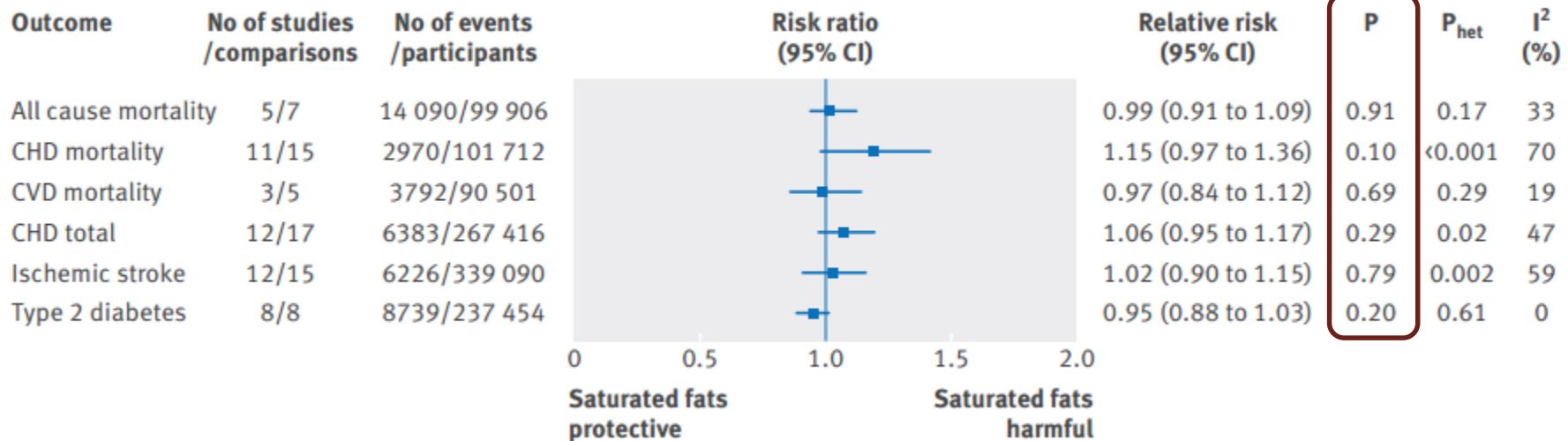


Hierarchy in Scientific Evidence



Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies

Russell J de Souza,^{1,2,3,4} Andrew Mente,^{1,2,5} Adriana Maroleanu,² Adrian I Cozma,^{3,4} Vanessa Ha,^{1,3,4} Teruko Kishibe,⁶ Elizabeth Uleryk,⁷ Patrick Budykowski,⁴ Holger Schünemann,^{1,8} Joseph Beyene,^{1,2} Sonia S Anand^{1,2,5,8}



BMJ 2015;351:h3978 | doi:10.1136/bmj.h3

Similar conclusion in a previous meta-analysis of prospective cohort studies and CVD. (Siri-Tarino et al., Am J Clin Nutr 2010;91:535–46)

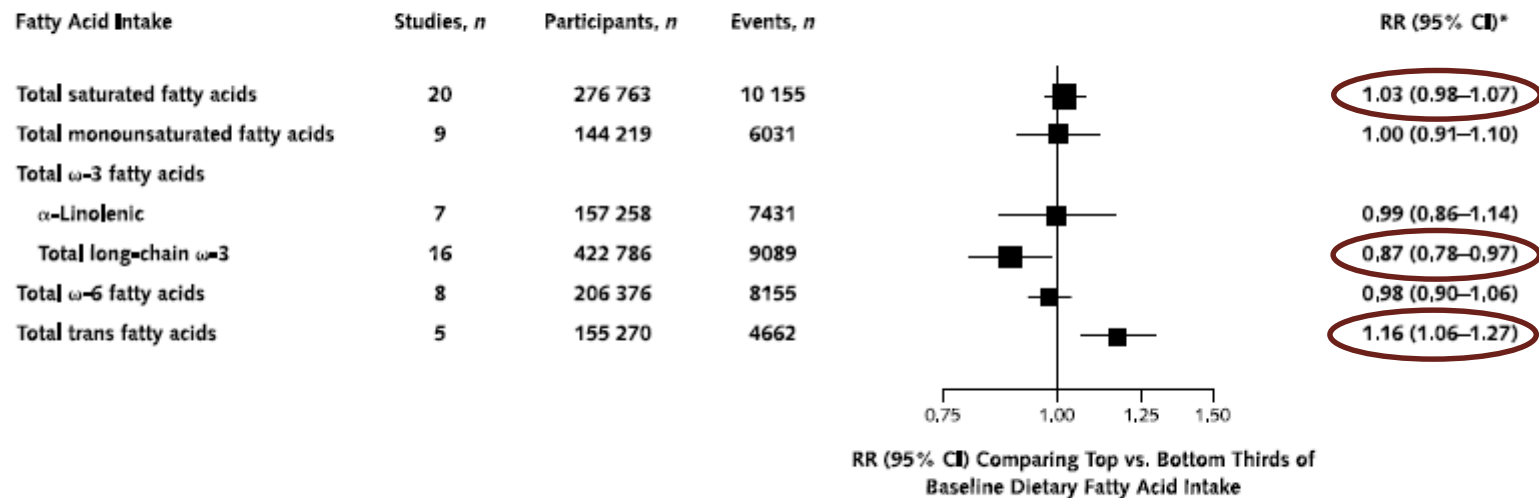


Association of Dietary, Circulating, and Supplement Fatty Acids With Coronary Risk

A Systematic Review and Meta-analysis

Rajiv Chowdhury, MD, PhD; Samantha Warnakula, MPhil*; Setor Kunutsor, MD, MSt*; Francesca Crowe, PhD; Heather A. Ward, PhD; Laura Johnson, PhD; Oscar H. Franco, MD, PhD; Adam S. Butterworth, PhD; Nita G. Forouhi, MRCP, PhD; Simon G. Thompson, FMedSci; Kay-Tee Khaw, FMedSci; Darlusch Mozaffarian, MD, DrPH; John Danesh, FRCP*; and Emanuele DI Angelantonio, MD, PhD*

Figure 1. RRs for coronary outcomes in prospective cohort studies of dietary fatty acid intake.



Size of the data marker is proportional to the inverse of the variance of the RR. RR = relative risk.

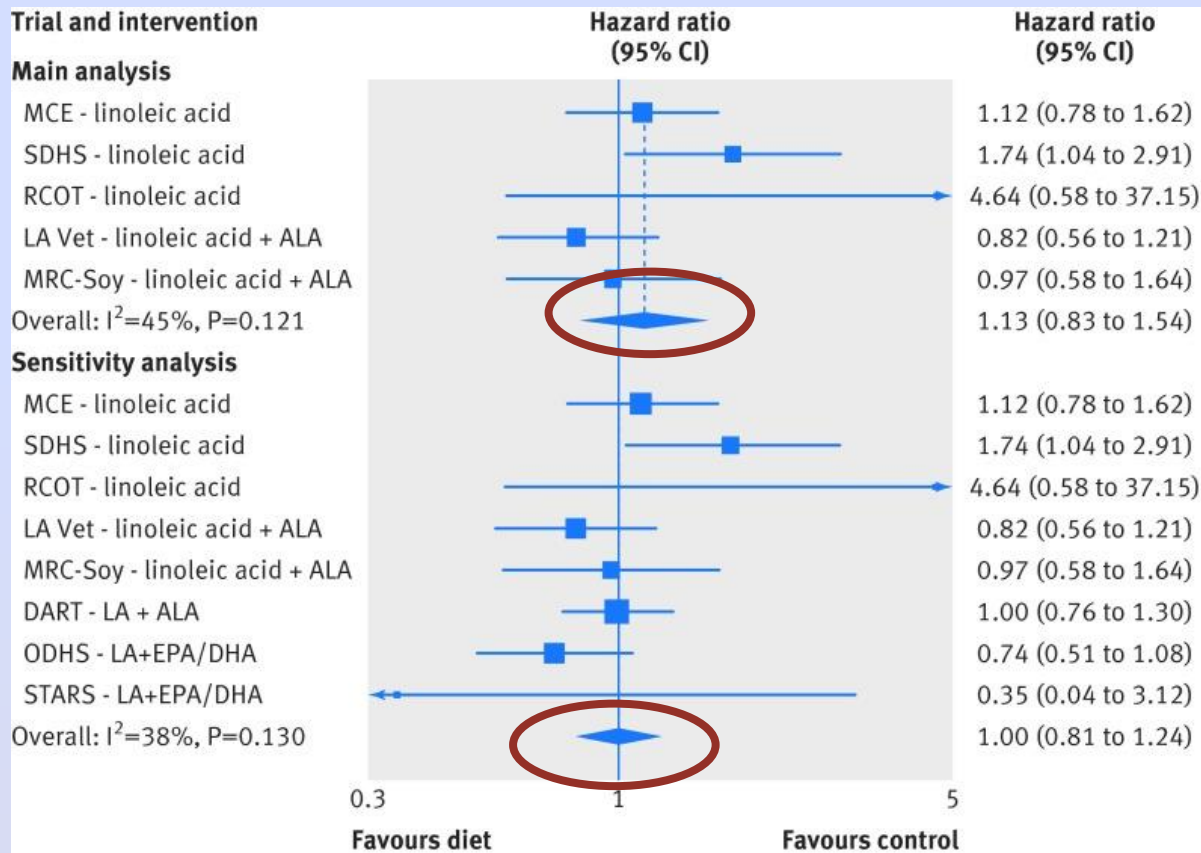
* Pooled estimate based on random-effects meta-analysis. Corresponding forest plots, I^2 estimates, and pooled RRs based on fixed-effects meta-analysis are provided in Supplement 1, available at www.annals.org.

Randomized controlled trials: Saturated fat versus PUFA



Re-evaluation of the traditional diet-heart hypothesis: analysis of recovered data from Minnesota Coronary Experiment (1968-73)

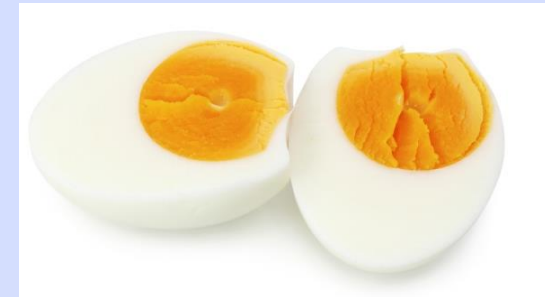
Christopher E Ramsden,^{1,2} Daisy Zamora,³ Sharon Majchrzak-Hong,¹ Keturah R Faurot,² Steven K Broste,⁴ Robert P Frantz,⁵ John M Davis,^{3,6} Amit Ringel,¹ Chirayath M Suchindran,⁷ Joseph R Hibbeln¹



Meta-analysis for **mortality from coronary heart disease** in trials testing replacement of saturated fat with vegetable oils rich in linoleic acid. Main analysis: trials provided replacement foods (vegetable oils) and were not confounded by any concomitant interventions.

Can we predict the health effects of foods based on the information on the label ?

Or just by the content of saturated fat ?



From single nutrients to whole foods: the importance of the food matrix



Updated meta-analysis of fermented dairy and CVD and mortality



Total 29 cohort studies are available for meta-analysis. Inverse associations were found between total fermented (included sour milk products, yogurt or cheese) with mortality (RR 0.98, 95% CI: 0.97-0.99; $I^2=94.4\%$) and risk of CVD (RR 0.98, 95% CI: 0.97-0.99; $I^2=87.5\%$). Also stratified analysis of total fermented dairy of cheese shown a lower 2% lower risk of CVD (RR 0.98, 95% CI: 0.95-1.00; $I^2=82.6\%$). No associations were found for total dairy, high-fat/ low-fat dairy or milk with the health outcomes.

Dairy and body weight regulation

International Journal of Obesity (2012) 1 - 9

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www.nature.com/ijo

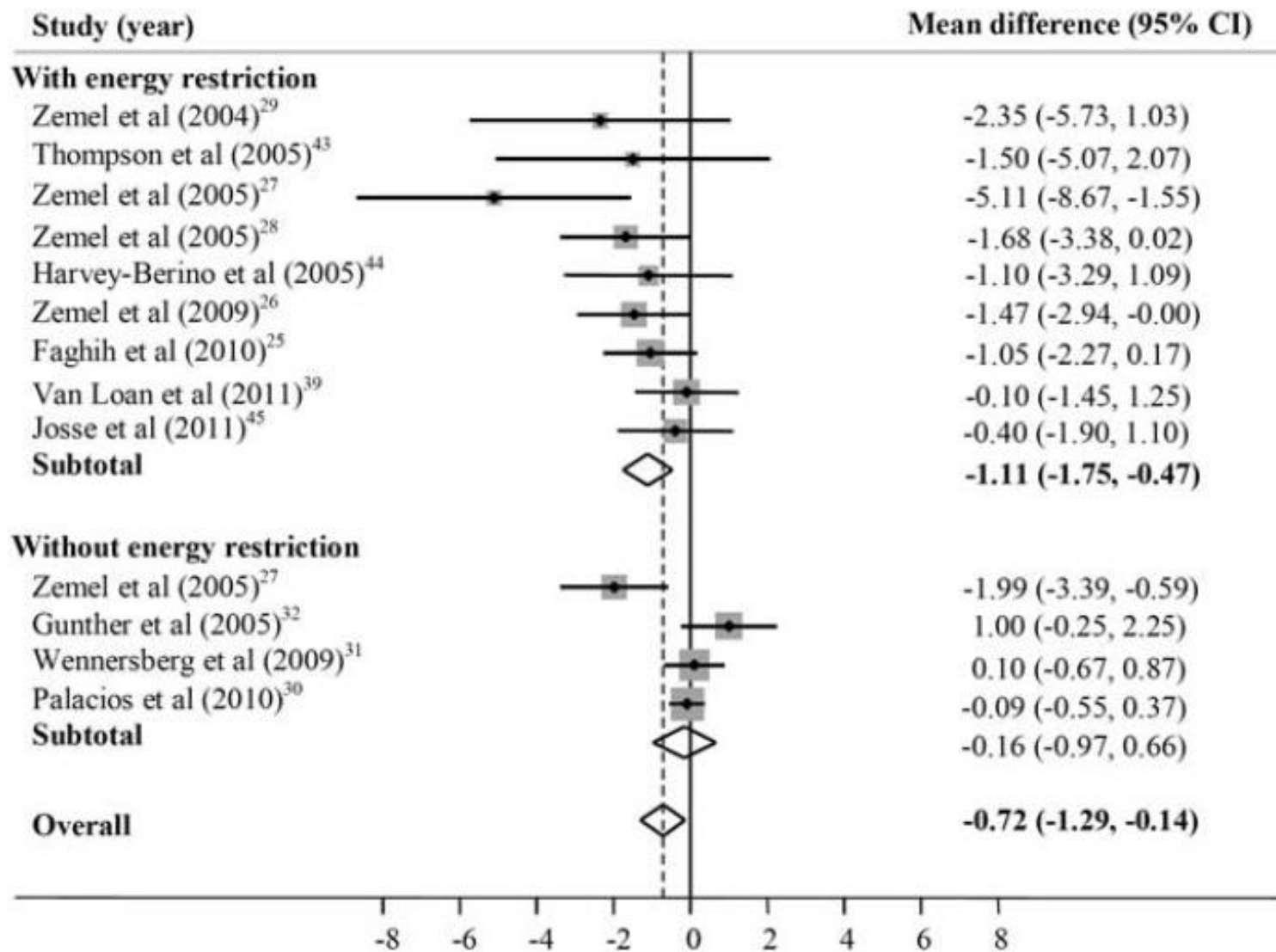
ORIGINAL ARTICLE

Effect of dairy consumption on weight and body composition in adults: a systematic review and meta-analysis of randomized controlled clinical trials

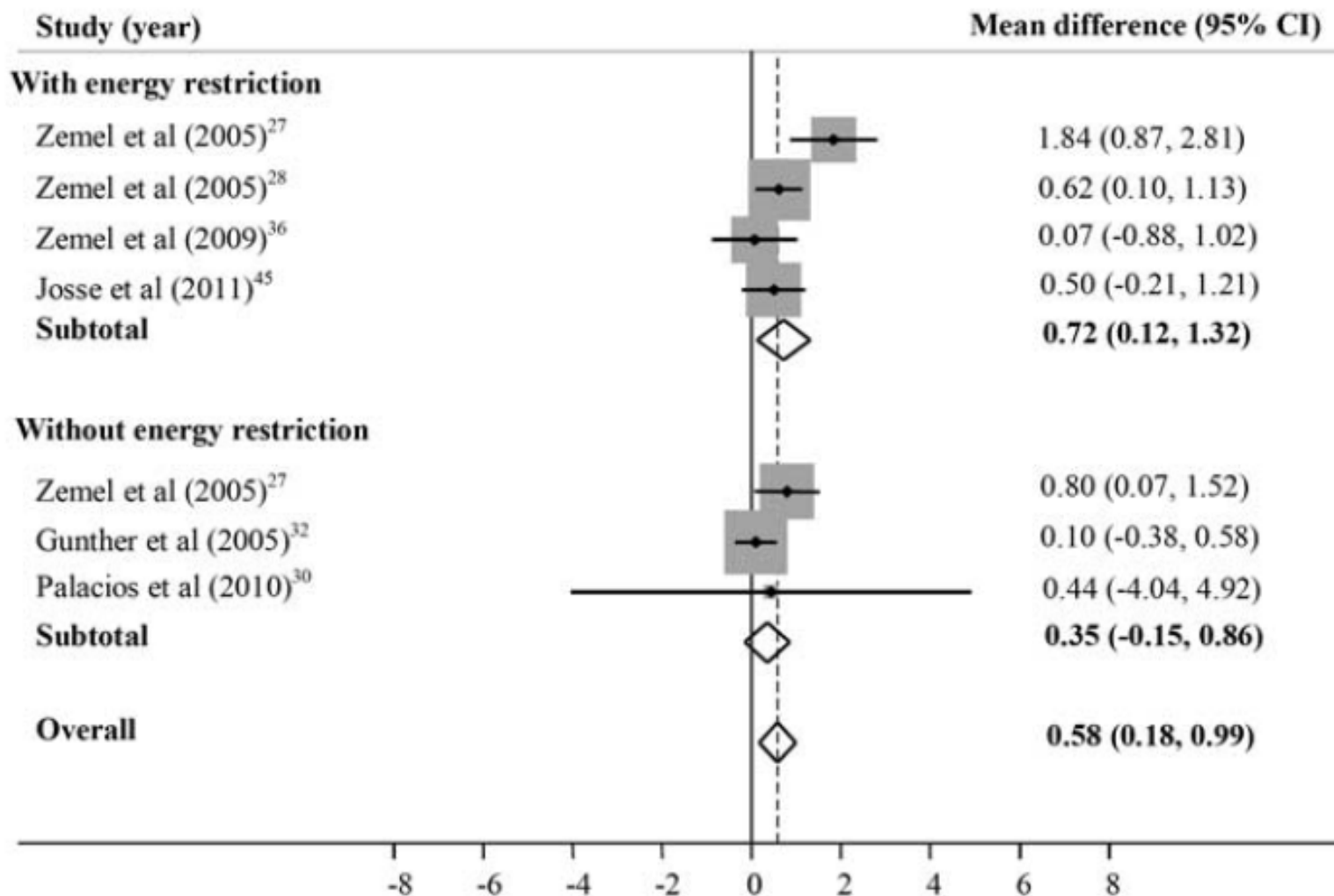
AS Abargouei^{1,2}, M Janghorbani³, M Salehi-Marzijarani³ and A Esmailzadeh^{1,2}



Effect of high vs low dairy on fat loss



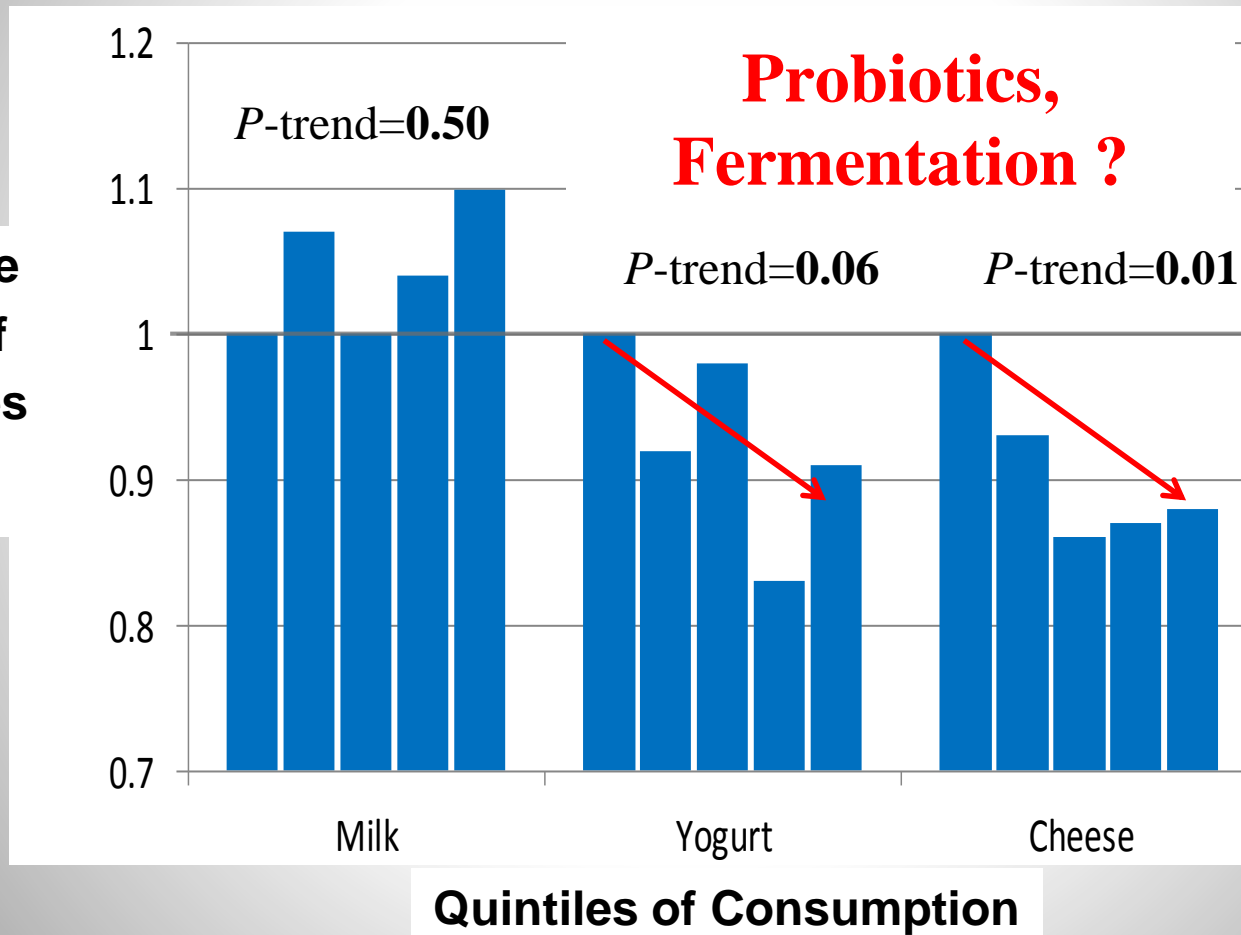
Effect of high vs low dairy on fat free mass



Dairy Foods and Risk of Diabetes

340,234 Europeans, 8 countries, 12,403 cases

Relative
Risk of
Diabetes



Sluijjs et al., AJCN
2012



Effects of cheese on CVD risk factors & Mechanisms

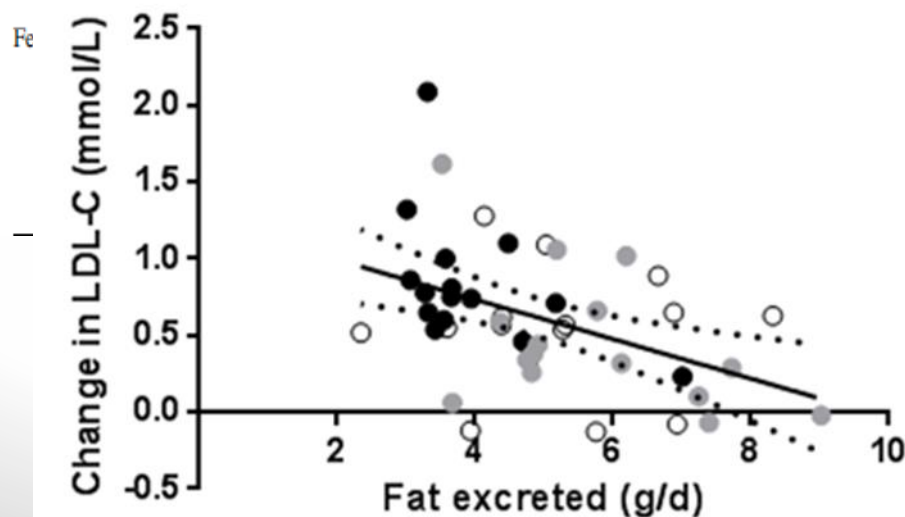
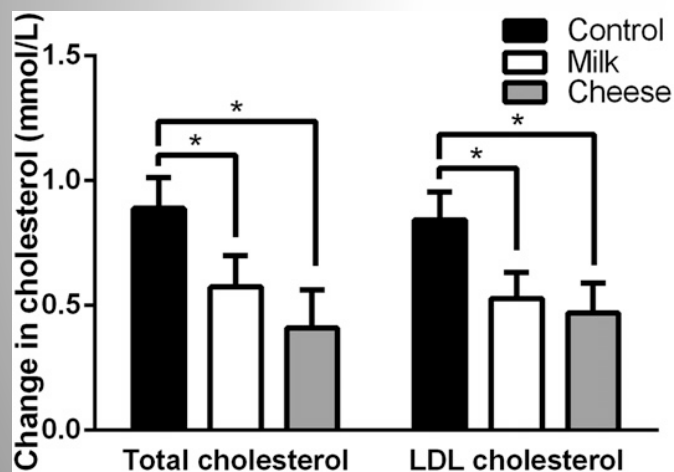
The cheese food matrix and mechanisms



Calcium in cheese and lipid metabolism

Effect of dairy calcium from cheese and milk on fecal fat excretion, blood lipids, and appetite in young men¹⁻³

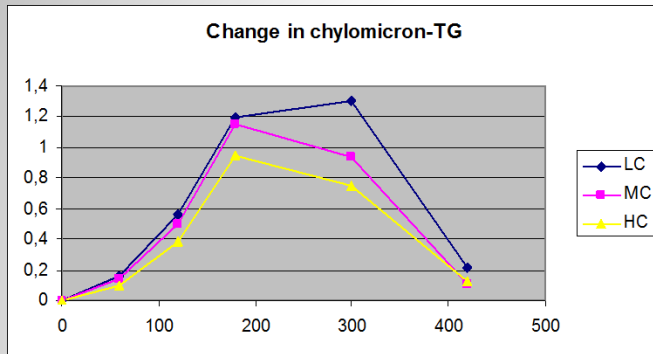
Karina V Soerensen, Tanja K Thorning, Arne Astrup, Mette Kristensen, and Janne K Lorenzen



Group	Fe	P diet
Control	3.0 ^b	0.002
Milk	6.0 ^{ab}	0.032
Cheese	0.3	NS
Control	0.4 ^b	<0.001
Cheese	0.3 ^b	0.006

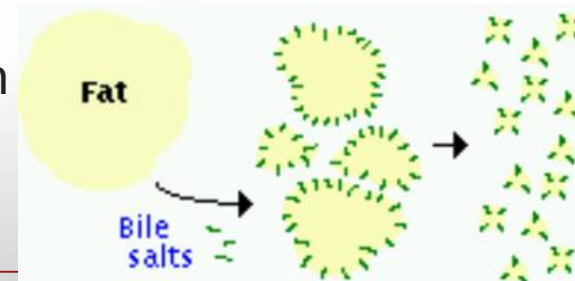
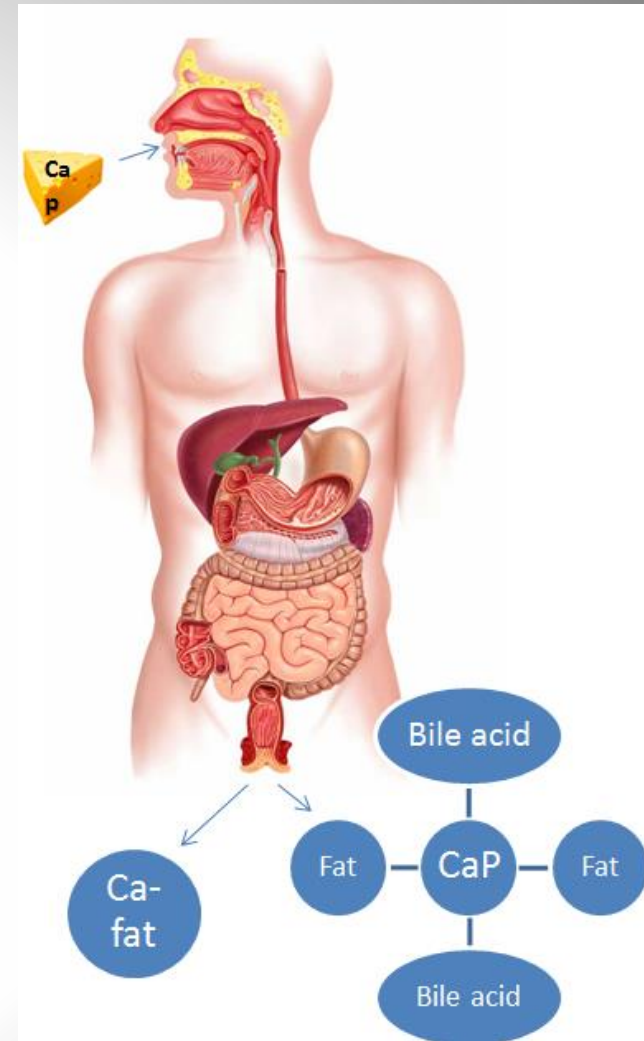
Suggested mechanisms

- Reduction in fat digestibility/absorption by calcium



Lorenzen JK, Astrup A. Am. J. Clin. Nutr. (2007)

- Precipitation of calcium and fatty acids in insoluble fatty acid soaps
- Precipitation of calcium and phosphate in amorphous calcium phosphate
- Possibly also increased fecal excretion of bile acids



Metabolomics investigation to shed light on cheese as a possible brick in the French paradox puzzle

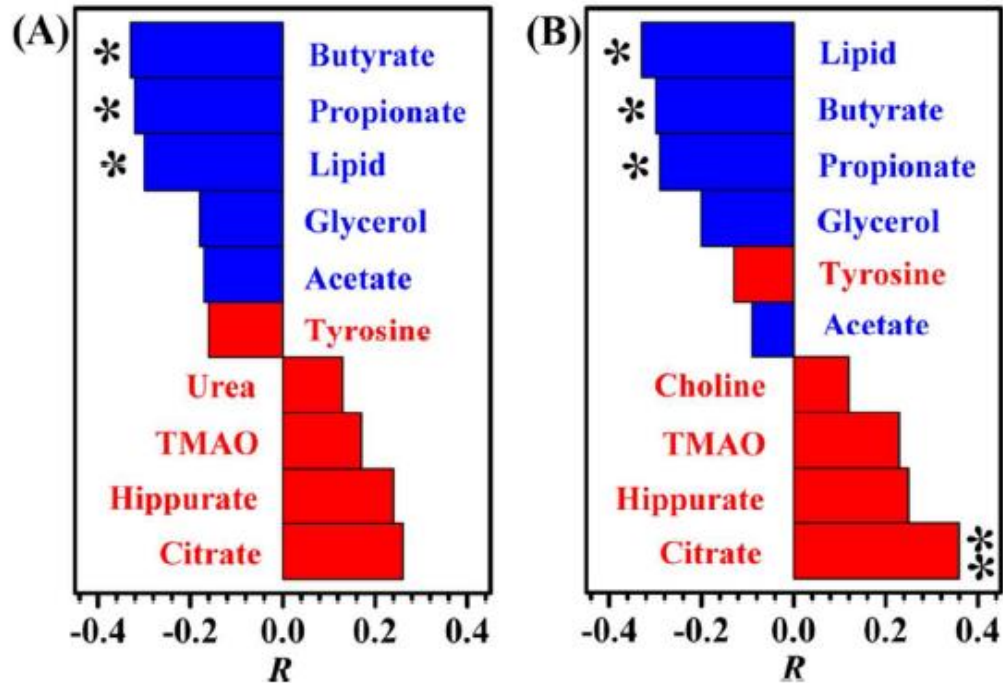
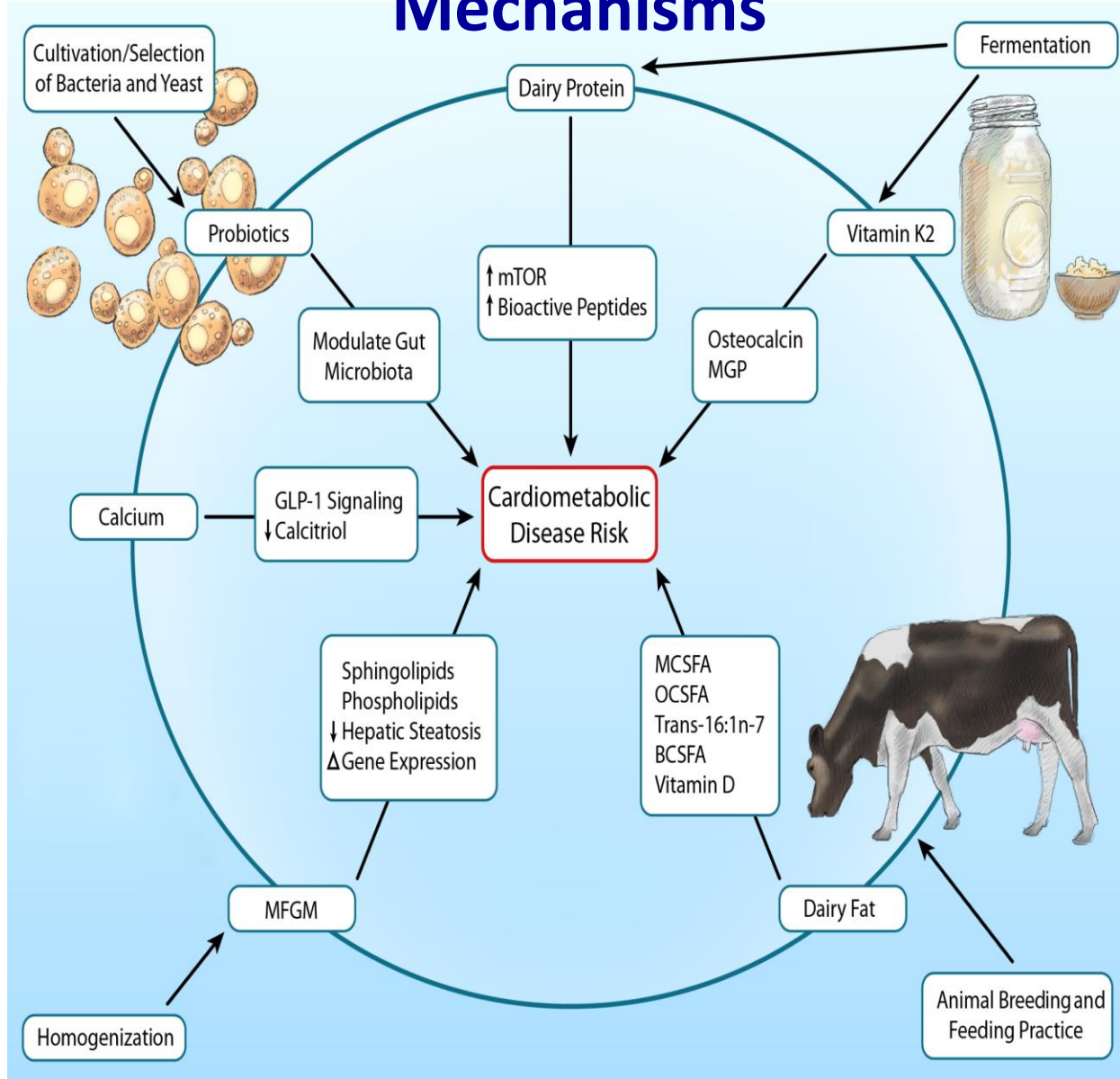


Figure 6. Top 10 metabolites correlated with the diet-induced increases in (A) total and (B) LDL cholesterol based on Pearson correlation coefficients. Red and blue bar represents urinary and fecal metabolites, respectively. *, $P < 0.05$; **, $P < 0.01$.

Dairy & Cardiometabolic Health: Potential Mechanisms



Mozaffarian & Wu,
Circulation Res 2018

The relevance of dairy matrix for bone health

Lead Article

Veganism, vegetarianism, bone mineral density, and fracture risk: a systematic review and meta-analysis

Isabel Iguacel*, María L. Miguel-Berges*, Alejandro Gómez-Bruton, Luis A. Moreno, and Cristina Julián

Context: The numbers of vegans and vegetarians have increased in the last decades. However, the impact of these diets on bone health is still under debate.

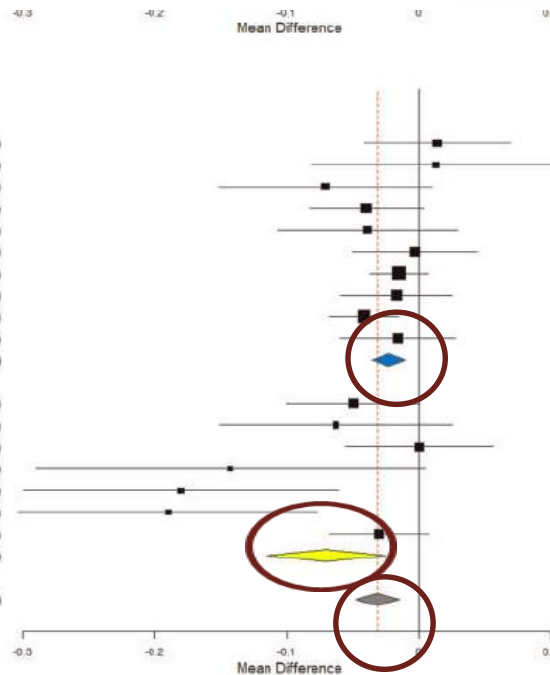
Objective: This systematic review and meta-analysis sought to study the impact of vegetarian and vegan diets on bone mineral density (BMD) and fracture risk. **Data**

Downloaded from <https://academic.ou>

Random-effects meta-analysis of the effects of vegetarian and vegan diets on bone mineral density (BMD) at the lumbar spine (LS).

B

Reference	Estimate (95%CI)
Lloyd et al (1991) ²⁴ (vegetarian women)	0.014 (-0.041, 0.069)
Tesar et al (1992) ²⁵ (vegetarian women)	0.013 (-0.082, 0.108)
Barr et al (1998) ²⁷ (vegetarian women)	-0.071 (-0.152, 0.010)
Lau et al (1998) ²⁷ (vegetarian women)	-0.040 (-0.093, 0.003)
Outila et al (2000) ²⁸ (vegetarian women)	-0.039 (-0.107, 0.029)
Kim et al (2007) ²⁶ (vegetarian women)	-0.003 (-0.050, 0.044)
Wang et al (2008) ²⁹ (vegetarian women)	-0.015 (-0.037, 0.007)
Krivosikova et al (2009) ³⁰ (vegetarian women)	-0.017 (-0.059, 0.025)
Yin-Ming et al (2010) ³¹ (vegetarian women)	-0.042 (-0.068, -0.016)
Kaur et al (2013) ³² (vegetarian women)	-0.016 (-0.060, 0.028)
Subgroup Vegetarian (I² =0 %, P=0.553)	-0.023 (-0.035, -0.010)
Chiu et al (1997) ²⁶ (vegan women)	-0.050 (-0.100, 0.000)
Barr et al (1998) ²⁷ (vegan women)	-0.063 (-0.152, 0.026)
Lau et al (1998) ²⁷ (vegan women)	0.000 (-0.056, 0.056)
Outila et al (2000) ²⁸ (vegan women)	-0.143 (-0.290, 0.004)
Fontana et al (2005) ³³ (vegan women)	-0.180 (-0.295, -0.061)
Fontana et al (2005) ³³ (vegan men)	-0.190 (-0.304, -0.076)
Ho-Pham et al (2006) ³⁴ (vegan women)	-0.030 (-0.069, 0.009)
Subgroup Vegan (I² =62.83 %, P=0.013)	-0.070 (-0.116, -0.025)
Overall (I² =41.04 %, P=0.040)	-0.032 (-0.048, -0.015)



◆ Vegetarians and vegans, ◆ Only vegetarians, ◆ Only vegans, ◆ Overall results.



Effect of vegetarian and vegan diet on whole body BMD

B

Reference	Estimate (95%CI)
Siani et al (2003) ³⁰ (vegetarian men and women)	0.000 (-0.075, 0.075)
Knurick et al (2015) ³⁸ (vegetarian men and women)	-0.060 (-0.116, -0.004)
Subgroup Vegetarian ($I^2 = 36.65\%$, $P=0.209$)	-0.035 (-0.093, 0.022)
Fontana et al (2005) ³¹ (vegan women)	-0.110 (-0.184, -0.036)
Fontana et al (2005) ³¹ (vegan men)	-0.120 (-0.242, 0.002)
Ho-Pham et al (2009) ³⁴ (vegan women)	-0.020 (-0.051, 0.011)
Knurick et al (2015) ³⁸ (vegan men and women)	-0.050 (-0.108, 0.008)
Subgroup Vegan ($I^2 = 55.9\%$, $P=0.078$)	-0.059 (-0.106, -0.012)
Overall ($I^2 = 40.37\%$, $P=0.136$)	-0.048 (-0.080, -0.016)

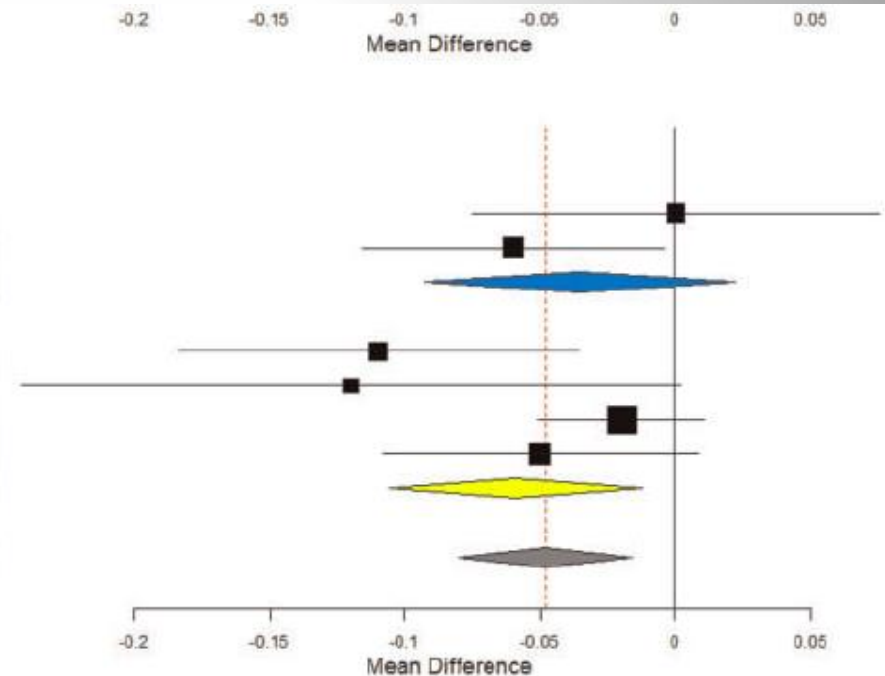
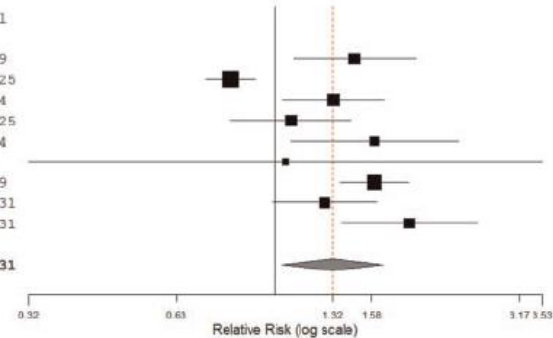


Figure 4 Random-effects meta-analysis of the effects of vegetarian and vegan diets on bone mineral density (BMD) on the whole body (WB). (a) BMD differences between vegetarians/vegans and omnivores. (b) Subgroup analyses by diet (vegetarians vs vegans). (c)

Effect of vegetarian and vegan diet on fractures

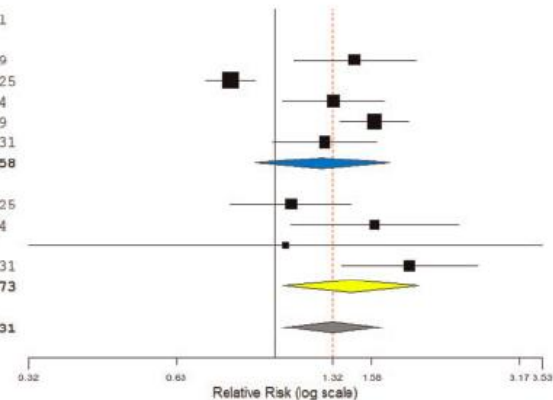
A

Reference	Estimate (95%CI)	Ev/Trt	Ev/Ctrl
Thorpe (2007) ³⁸ (vegetarian women)	1.460 (1.096, 1.946)	81/718	88/1139
Appleby (2007) ³⁹ (vegetarian women)	0.816 (0.726, 0.918)	368/7272	913/14725
Appleby (2007) ³⁹ (vegetarian men)	1.323 (1.044, 1.676)	103/1968	179/4524
Appleby (2007) ³⁹ (vegan women)	1.083 (0.816, 1.437)	47/700	913/14725
Appleby (2007) ³⁹ (vegan men)	1.602 (1.082, 2.371)	27/426	179/4524
Ho-Pham (2012) ⁴⁰ (vegan women)	1.057 (0.317, 3.526)	5/88	5/93
Dash (2012) ⁴⁰ (vegetarian women)	1.599 (1.362, 1.877)	209/2131	395/6439
Lousuebsakul-Matthews (2014) ⁴¹ (vegetarian women and men)	1.268 (0.991, 1.624)	130/13524	120/15831
Lousuebsakul-Matthews (2014) ⁴¹ (vegan women and men)	1.887 (1.371, 2.596)	54/3776	120/15831
Overall ($I^2 = 87.8\%$, $P < 0.001$)	1.316 (1.038, 1.668)	1024/30603	2912/77831



B

Reference	Estimate (95%CI)	Ev/Trt	Ev/Ctrl
Thorpe (2007) ³⁸ (vegetarian women)	1.460 (1.096, 1.946)	81/718	88/1139
Appleby (2007) ³⁹ (vegetarian women)	0.816 (0.726, 0.918)	368/7272	913/14725
Appleby (2007) ³⁹ (vegetarian men)	1.323 (1.044, 1.676)	103/1968	179/4524
Dash (2012) ⁴⁰ (vegetarian women)	1.599 (1.362, 1.877)	209/2131	395/6439
Lousuebsakul-Matthews (2014) ⁴¹ (vegetarian women and men)	1.268 (0.991, 1.624)	130/13524	120/15831
Subgroup Vegetarian ($I^2 = 92.43\%$, $P = 0.000$)	1.254 (0.917, 1.714)	891/25613	1695/42658
Appleby (2007) ³⁹ (vegan women)	1.083 (0.816, 1.437)	47/700	913/14725
Appleby (2007) ³⁹ (vegan men)	1.602 (1.082, 2.371)	27/426	179/4524
Ho-Pham (2012) ⁴⁰ (vegan women)	1.057 (0.317, 3.526)	5/88	5/93
Lousuebsakul-Matthews (2014) ⁴¹ (vegan women and men)	1.887 (1.371, 2.596)	54/3776	120/15831
Subgroup Vegan ($I^2 = 58.08\%$, $P = 0.067$)	1.439 (1.047, 1.977)	133/4990	1217/35173
Overall ($I^2 = 87.8\%$, $P = 0.000$)	1.316 (1.038, 1.668)	1024/30603	2912/77831



Random effects meta-analysis of the effects of vegetarian and vegan diets on fracture rates.

Bian et al. *BMC Public Health* (2018) 18:165
DOI 10.1186/s12889-018-5041-5

BMC Public Health

RESEARCH ARTICLE

Open Access



Dairy product consumption and risk of hip fracture: a systematic review and meta-analysis

Shanshan Bian^{1†}, Jingmin Hu^{1†}, Kai Zhang¹, Yunguo Wang², Miaohui Yu³ and Jie Ma^{3*}



Conclusions: Our findings indicate that consumption of yogurt and cheese was associated with lower risk of hip fracture in cohort studies. However, the consumption of total dairy products and cream was not significantly associated with the risk of hip fracture. There was insufficient evidence to deduce the association between milk consumption and risk of hip fracture. A lower threshold of 200 g/day milk intake may have beneficial effects, whereas the effects of a higher threshold of milk intake are unclear.

5 April 2019

Dias 26

a

Study

Type = Milk

Sahni 2014
Owusu 1997
Meyer(Female) 1997
Meyer(Male) 1997
Fujiwara 1997
Cumming 1997
Michaelsson (Female) 2014
Michaelsson (Male) 2014
Feskanich (NHS) 2014
Feskanich (HPFS) 2014
Feart 2013
Kanis(Female) 2004
Kanis(Male) 2004
Random effects model
Heterogeneity: $I^2 = 75\%$, $p < 0.01$

Type = Yogurt

Sahni 2014
Michaelsson (Female) 2014
Michaelsson (Male) 2014
Feart 2013
Random effects model
Heterogeneity: $I^2 = 0\%$, $p = 0.42$

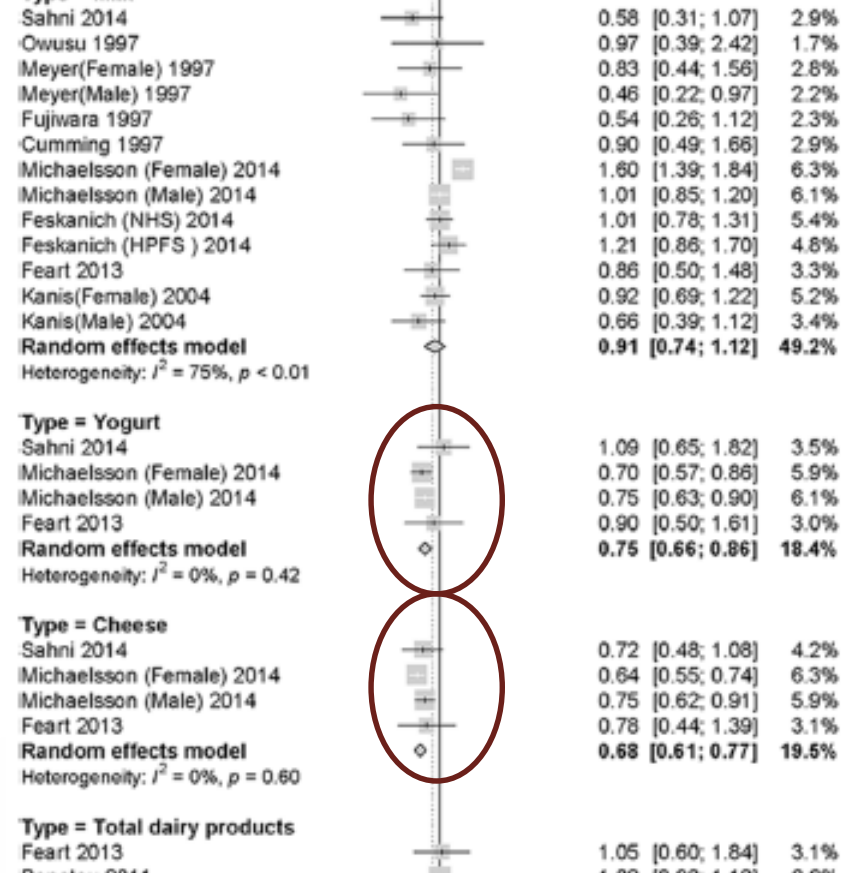
Type = Cheese

Sahni 2014
Michaelsson (Female) 2014
Michaelsson (Male) 2014
Feart 2013
Random effects model
Heterogeneity: $I^2 = 0\%$, $p = 0.60$

Type = Total dairy products

Feart 2013

Relative risk 95%CI Weight



Heterogeneity: $I^2 = 81\%$, $p < 0.01$


0.05 0.5 1 2 10 20

Osteoporos Int
<https://doi.org/10.1007/s00198-017-4285-8>



ORIGINAL ARTICLE

Milk and other dairy foods and risk of hip fracture in men and women

D. Feskanich¹  · H. E. Meyer^{2,3} · T. T. Fung⁴ · H. A. Bischoff-Ferrari⁵ · W. C. Willett^{1,6}

- Each serving of milk per day was associated with a significant 8% lower risk of hip fracture in men and women combined (RR = 0.92, 95% confidence interval (CI) 0.87 to 0.97).
- A suggestive inverse association was found for cheese in women only (RR = 0.91, CI 0.81 to 1.02).
- Total dairy food intake, of which milk contributed about half, was associated with a significant 6% lower risk of hip fracture per daily serving in men and women (RR = 0.94, CI 0.90 to 0.98).
- **Calcium, vitamin D, and protein from non-dairy sources did not modify the association between milk and hip fracture, nor was it explained by contributions of these nutrients from milk**



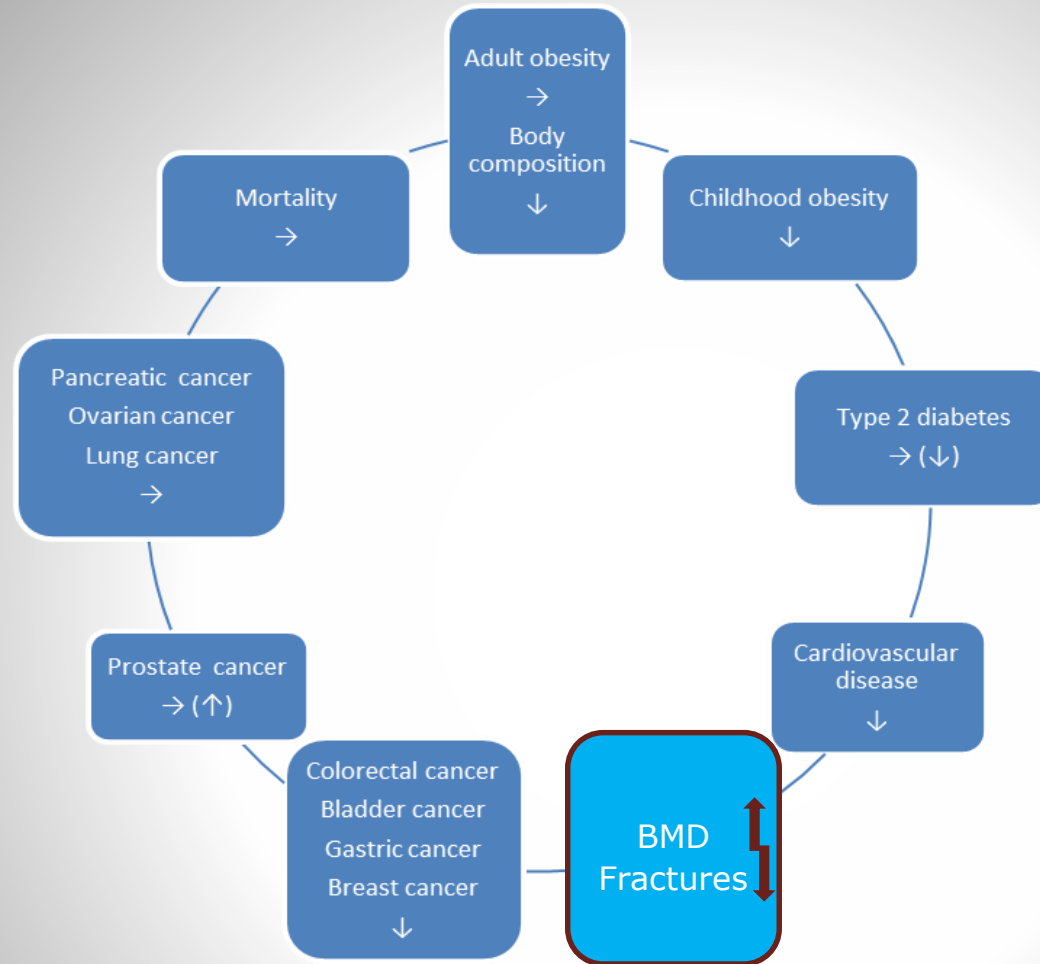


Figure 1. Overall effect/association between dairy (cheese and yogurt) intake and health outcomes. ↓favorable effect/association; ↑adverse effect/association; → no effect/association.

Conclusions

- The totality of evidence i.e. meta-analyses of both observational studies and RCT's cannot find any harmful effects of dairy on body fat, metabolic syndrome, type 2 diabetes, or CVD.
- Yogurt and cheese does not exert the detrimental effects on blood lipids and blood pressure as previously predicted by its sodium and saturated fat content.
- Dairy, in particular full-fat, exerts beneficial effects on LDL-cholesterol, blood pressure and postprandial triglycerides as compared to butter.
- Meta-analysis of observational studies support that full fat yogurt and cheese (and perhaps other fermented dairy) may protect from CVD, type 2 diabetes, osteopenia and osteoporotic fractures.
- The effects of yogurt and cheese on body composition, diabetes and CVD risks can be attributed to the food matrix with nutrients i.e. protein, calcium, SCFA from fermentation, and perhaps peptides, phospholipids.
- Whereas the low-fat version might be helpful for non-diabetic overweight and obese individuals, the full-fat versions are optimal for type 2 diabetics.
- A diet including dairy, particularly yogurt and cheese should be recommended for all to prevent and manage type 2 diabetes, cardiovascular disease and osteopenia/osteoporosis.

